§17. Critical Gradients for Short Wavelength Ion Temperature Gradient Instability in Toroidal Plasmas

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Recently, the short wavelength ion temperature gradient (SWITG) instability has attracted increasing attention, partly because it can produce a significant level of anomalous transport with mixing length estimate theory and partly because the excitation of the SWITG mode seems to requires both ion and electron temperature gradient (η_i and η_e) exceed thresholds. We studied the physical mechanism of toroidal SWITG instability and confirmed that the double-humped behavior in the growth rate, that is, conventional ITG and SWITG modes, is attributable to the toroidal drift/Landau resonance mechanism and the nonmonotonic behavior of the effective frequency as the wavelength varies. In this paper, a systematic parameter study of the toroidal SWITG modes is performed with a gyrokinetic integral code. Marginal stability curve in $\eta_e - \eta_i$ space is numerically obtained, as well as the scaling of the critical gradient with respect to temperature ratio, toroidicity, and magnetic shear and safety factor. Algebraic formulae for the critical gradient are presented. Possibility of the SWITG instability as a possible candidate to explain anomalous transport is discussed.

We employ a gyrokinetic integral equation code, where the ballooning representation for an axisymmetric toroidal geometry with circular flux is applied. The magnetic curvature and gradient drift, transit effect and finite Larmor radius effect are all retained for both ions and electrons, but the finite β and trapped particle effect are neglected. The eigenmode equation is as follows

$$(1+Z_i\tau_i)\phi(k) = \int_{-\infty}^{\infty} dk'/\sqrt{\pi}[H_j(k,k')\phi(k')]$$

where ϕ (k) is the extended Fourier component in ballooning space of ϕ (r).

The stabilization diagram of the l =0 and $l=1$ modes in $\eta_e - \eta_i$ space is shown in Fig. 1.

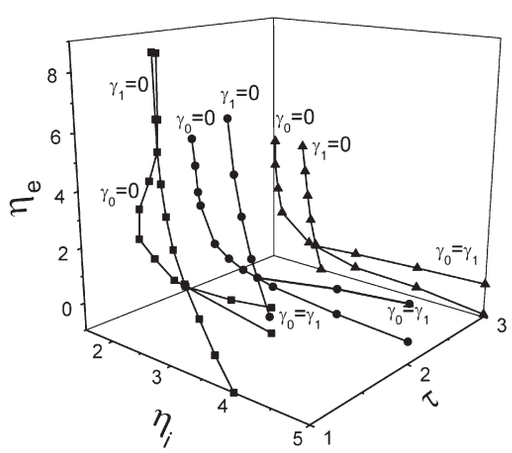

Fig.1 The stabilization diagram in the $\eta_e - \eta_i$ space

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